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BOONTON

BOONTON ELECTRONICS CORPORATION

PRELIMINARY

INSTRUCTION MANUAL

MODEL 8200
MODULATION ANALYZER

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PRELIMINARY

INSTRUCTION MANUAL

MODEL 8200
MODULATION ANALYZER

NOTE:

The 8200 Manual is being printed and is not ready. This preliminary manual is enclosed so that the instrument can be shipped without delay. A complete manual will be mailed to you as soon as it is available.

7-31-85

BOONTON
ELECTRONICS CORPORATION

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984012-00

SAFETY SUMMARY

The following general safety precautions must be observed during all phases of operation and maintenance of this instrument. Failure to comply with these precautions or with specific warnings elsewhere in this manual violates safety standards of design, manufacture, and intended use of the instrument. Boonton Electronics assumes no liability for the customer's failure to comply with these requirements.

THE INSTRUMENT MUST BE GROUNDED

To minimize shock hazard the instrument chassis and cabinet must be connected to an electrical ground. The instrument is equipped with a three conductor, three prong a.c. power cable. The power cable must either be plugged into an approved three-contact electrical outlet or used with a three-contact to a two-contact adapter with the (green) grounding wire firmly connected to an electrical ground at the power outlet.

DO NOT OPERATE THE INSTRUMENT IN AN EXPLOSIVE ATMOSPHERE.

Do not operate the instrument in the presence of flammable gases or fumes.

KEEP AWAY FROM LIVE CIRCUITS.

Operating personnel must not remove instrument covers. Component replacement and internal adjustments must be made by quailfied maintenance personnel. Do not replace components with the power cable connected. Under certain conditions dangerous voltages may exist even though the power cable was removed, therefore: always disconnect power and discharge circuits before touching them.

DO NOT SERVICE OR ADJUST ALONE.

Do not attempt internal service or adjustment unless another person, capable of rendering first aid and resuscitation, is present.

DO NOT SUBSTITUTE PARTS OR MODIFY INSTRUMENT.

Do not install substitute parts or perform any unauthorized modification of the insturment. Return the instrument to Boonton Electronics for repair to ensure that the safety features are maintained.

SAFETY SYMBOLS.

This safety requirement symbol (located on the rear panel) has been adopted by the International Electrotechnical Commission, Document 66 (Central Office) 3, Paragraph 5.3, which directs that and instrument be so labeled if, for the correct use of the instrument, it is necessary to refer to the instruction manual. In this case it is recommended that reference be made to the instruction manual when connecting the instrument to the proper power source. Verify that the correct fuse is installed for the power available, and that the switch on the rear panel is set to the applicable operating voltage.

CAUTION

The CAUTION sign denotes a hazard. It calls attention to an operation procedure, practice, or the like, which, if not correctly performed or adhered to, could result in damage to or destruction of part or all of the equipment. Do not proceed beyond a CAUTION sign until the indicated conditions are fully understood and met.

WARNING

The WARNING sign denotes a hazard. It calls attention to an operation procedure, practice, or the like, which, if not correctly performed or adhered to, could result in injury or loss of life. Do not proceed beyond a WARNING sign until the indicated conditions are fully understood and met.

Indicates dangerous voltages.

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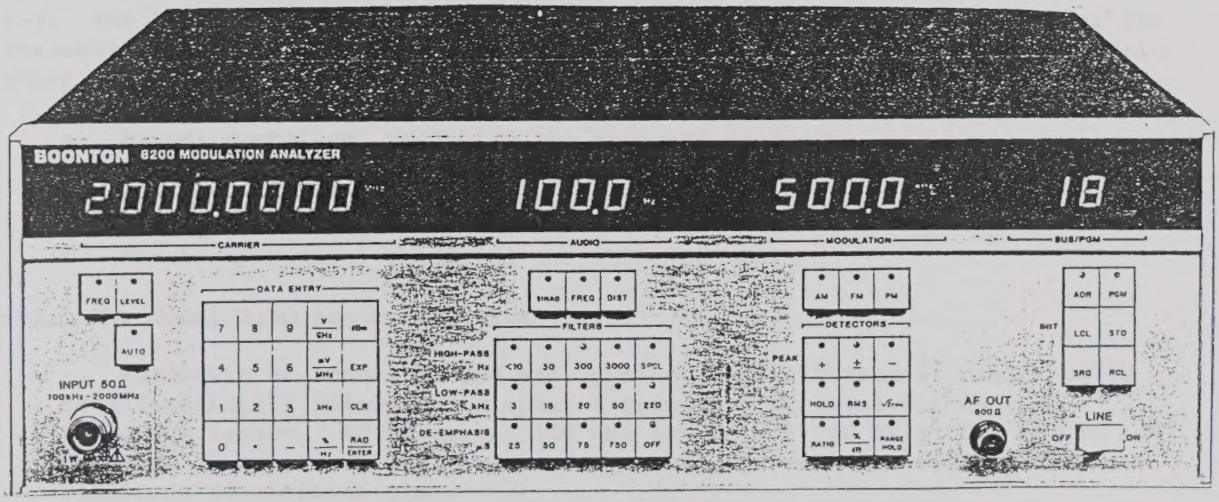

Model 8200 Modulation Analyzer

SECTION I
GENERAL INFORMATION

1-1. Introduction. This instruction manual provides general information, installation and operating instructions, theory of operation, maintenance instructions, and parts list for the Model 8200 Modulation Analyzer.

1-2. Description. The Model 8200 Modulation Analyzer is microprocessor-based modulation analyzer that is capable of analyzing AM, FM, and PM signals over the frequency range of 100 kHz to 2 GHz and a level range from 10 mV rms at 100 kHz to 520 MHz, 30 mV at 520 MHz to 1.5 GHz, and 50 mV at 1.5 GHz to 2.0 MHz. See Figure 1-1. The Model 8200 provides a fully implemented interactive IEEE-488 bus interface and a built-in non-volatile program memory.

1-3. The Model 8200 is designed to perform laboratory and production tests for transmitters and signal generators. The instrument has three modes of operation which are as follows:

a. Manual operation, utilizing the keyboard controls.

b. Automatic operation, utilizing the AUTO key.

c. Remote operation, utilizing the IEEE-488 bus.

1-4. The Model 8200 design features are:

a. Automatic or manual tuning and leveling. The instrument can manually or automatically select and display a frequency or level within the following ranges: 10 mV rms at 100 kHz to 520 MHz, 30 mV at 520 MHz to 1.5 GHz, and 50 mV at 1.5 GHz to 2.0 MHz. Manual operation is recommended to eliminate acquisition time.

b. Four separate major function displays which show carrier frequency or level, audio frequency or distortion in percent or distortion SINAD, modulation AM, FM, or PM, program number or bus address, and IEEE-488 bus status.

c. A fully automatic distortion analyzer that can display distortion in percent or SINAD.

d. Low residual modulation that provides excellent measurement accuracy with low noise sources. Direct residual measurements are possible using the internal true rms detectors and the active peak detectors insure exceptional baseband detection linearity so that residuals may be easily discounted for enhanced measurement accuracy.

1-4. (Cont)

e. IEEE-488 bus: All instrument functions are programmable except bus address. Annunciators to the left of the BUS/PRGM numeric display show the status of bus activity. Bus operation is completely interactive with full talk and listen capabilities including return of values in talk mode. Memory contents can also be stored or recalled via the bus. The 8200 is designed to interface easily with controllers currently in use. A versatile free-form number entry system is used so that the 8200 will accept any conceivable valid number string. Formatting is therefore optional in the control program, which aids in getting an application up and running. Triggering may be performed in immediate or wait modes. There are four talk modes which can be addressed in either the remote or local state. Finally, the 8200 provides a choice of several end-of-string terminators which can be selected using internal switches. It can also be configured to activate the service request line if an error occurs. A front panel "local" switch will force return to local control when using the bus as long as a lockout message has not been sent.

1-5. Options.

1-6. The following option is available for the Model 8200:

a. -01 Avionics verification, additional calibration is done to insure additional avionics specifications.

b. -02 Rear panel RF IN connector, in place of the front panel connector.

1-7. Specifications.

1-8. Specifications are listed in Table 1-1.

1-9. Outline Dimensions.

1-10. Outline dimensions are shown in Figure 1-2.

TABLE 1-1. SPECIFICATIONS

PARAMETER	SPECIFICATION
RF INPUT:	
Carrier Frequency Range	100 kHz to 2.0 GHz.
Tuning	Automatic, typical aquisition time one second. Manual, from keyboard or IEEE-488 bus.
Sensitivity	10 mV rms, 100 kHz to 520 Mhz. 30 mV rms, 520 MHz to 1.5 GHz. 50 mV rms, 1.5 MHz to 2.0 GHz.
Level Set	Automatic, typical acquisition time one second for levels up to 2 V rms. Manual, from keyboard or IEEE-488 bus.
Maximum Safe Input	7 V rms. Supplied RF fuses may be installed for protection above 1 W; however, RF power measurement accuracy and carrier sensitivity specifications are degraded.
Input Impedance	50 nominal, SWR Less than 1.5.
CARRIER DISPLAY:	
Frequency	
Resolution	10 Hz for carriers below 1.0 GHz, 100 Hz above.
Accuracy	Referency accuracy one digit.
Reference Oscillator	10 MHz, temperature compensated.
Aging Rate	Less than 1x10-6/year.
Temperature Influence	Less than 1x10-6 from 0 to 50 degrees centigrade.
Level	
Resolution	0.1 dBm or 1 mV, -47.0 to +19.0 dBm. (1 mV to 2 V).
Accuracy	1 dB from 100 kHz to 520 MHz and -47.0 dBm to +19 dBm. 2 dB from 520 MHz to 1500 MHz and -37.0 dBm to +19 dBm. 3 dB from 1500 MHz to 2000 MHz and -33.0 dBm to +19 dBm.

TABLE 1-1 SPECIFICATIONS (CONT)

PARAMETER	SPECIFICATION		
MODULATION DISPLAY-FM			
	Carrier Frequency Range		
	0.2 to 0.5 MHz	0.5 to 10 MHz	10 to 2.0 GHz
Deviation Range	0 to $\frac{\text{C.F.}}{10}$ kHz	0 to 150 kHz	0 to 500 kHz
Deviation Accuracy.(1)(2) At specified Mod. Rates.	1% of reading 30 Hz to 5 kHz. 2% of reading 30 Hz to 7.5 kHz.	1% of reading 30 Hz to 15 kHz. 2% of reading 30 Hz to 30 kHz.	1% of reading 30 Hz to 100 kHz. 2% of reading 30 Hz to 150 kHz.
Modulation Frequency Range	20 Hz to 15 kHz	20 Hz to 50 kHz	20 Hz to 200 kHz
AF Output Distortion	Less than 0.1% at 30 kHz dev.	Less than 0.1% at 75 kHz dev.	Less than 0.1% at 100 kHz dev.
Residual FM	Less than 15 Hz rms at 2.0 GHz decreasing linearly to a floor of less than 1 Hz rms, with 3 kHz low-pass filter. Less than 30 Hz rms at 2.0 GHz decreasing linearly to a floor of less than 2 Hz rms, with 15 kHz low-pass filter.		
AM Rejection	Less than 20 Hz deviation at 50% AM. 30 Hz to 3 kHz filter.		
Display Resolution	1 Hz for deviation from 0 to 5 kHz peak. 10 Hz for deviations from 5 to 50 kHz peak. 100 Hz for deviations above 50 kHz.		
Stereo Separation	Greater than 48 dB, 50 Hz to 15 kHz modulation rates.		

NOTES

(1) Peak residuals must be accounted for to obtain above accuracy.

(2) For rms detector add 1% of reading.

TABLE 1-1 SPECIFICATIONS (CONT)

PARAMETER	SPECIFICATION		
MODULATION DISPLAY-PM			
	Carrier Frequency Range		
	0.2 to 0.5 MHz	0.5 to 10 MHz	10 to 2.0 GHz
Deviation Range (1)	0 to $\frac{C.F.}{10}$ rad	0 to 150 rad	0 to 500 rad
Deviation Accuracy (2)(3)	3% of reading 200 Hz to 15 kHz	3% of reading 200 Hz to 30 kHz	3% of reading 200 Hz to 30 kHz
Modulation Frequency Range	100 Hz to 7.5 kHz	100 Hz to 50 kHz	100 Hz to 100 kHz
AF Output Distortion	Less than 0.1% at 30 rad dev	Less than 0.1% at 75 rad dev	Less than 0.1% at 100 rad dev
Residual PM	Less than 0.1 rad rms at 2.0 GHz decreasing linearly to a floor of less than 0.005 rad rms.		
AM Rejection	Less than 0.02 rad deviation at 50% AM, 30 Hz to 3 kHz filter.		
Display Resolution (4)	0.001 rad for deviation from 0 to 5 rad peak. 0.01 rad for deviations from 5 to 50 rad peak. 0.1 rad for deviations above 50 rad peak.		

NOTES

(1) Up to 1 kHz modulation rate. Above 1 kHz range decreses linearly with modulation frequency.

(2) Peak residuals must be accounted for to obtain above accuracy.

(3) For rms detector add 1% of reading.

(4) Up to 1 kHz modulation rate. Above 1 kHz resolution is determined by product of deviation and modulation rate.

TABLE 1-1 SPECIFICATIONS (CONT)

PARAMETER	SPECIFICATION		
MODULATION DISPLAY-AM			
	Carrier Frequency Range		
	0.1 to 0.5 MHz	0.5 to 10 MHz	10 to 2.0 GHz
Depth Range	0 to 99%.	0 to 99%.	0 to 99%.
Depth Accuracy.(1)(2)(3) At specified mod. rates and depths.	1% of reading 10 to 90% AM, 3% of reading less than 10 and greater than 90% AM.		
	30 Hz to 5 kHz	30 Hz to 15 kHz	30 Hz to 100 kHz
	2% of reading 10 to 90% AM, 6% of reading less than 10 and greater than 90% AM.		
	30 Hz to 7.5 kHz	30 Hz to 30 kHz	30 Hz to 150 kHz
Modulation Frequency Range	20 Hz to 15 kHz	20 Hz to 50 kHz	20 Hz to 20 kHz
AF Output Distortion	Less than 0.3% for 90% AM.	Less than 0.3% for 90% AM.	Less than 0.3% for 90% AM.
Residual AM	Less than .05% AM rms for input levels above 100 mV rms, 15 kHz low-pass filter. Less than .02% AM rms for input levels above 100 mV rms, 3 kHz low-pass filter. Carrier frequency less than 520 MHz. Above 520 MHz, residuals increase linearly with frequency.		
FM Rejection			
Carrier frequency greater than 10 MHz	Less than 0.2% AM peak at 50 kHz peak deviation.		
Carrier frequency less than 10 MHz	Less than 0.2% AM peak at 5 kHz peak deviation.		

NOTES

(1) Peak residuals must be accounted for to obtain above accuracy.

(2) For rms detector add 1% of reading.

(3) Carrier frequency <520 MHz. RF level between -10 and +10 dBm.

TABLE 1-1. SPECIFICATIONS (CONT)

PARAMETER	SPECIFICATION
AUDIO DISPLAY	
Frequency	
Range	10 Hz to 200 kHz.
Resolution	100 Hz for frequencies greater than 100 kHz. 10 Hz for frequencies between 10 kHz and 100 kHz. 1 Hz for frequencies between 1 kHz and 10 kHz. 0.1 Hz for frequencies below 1 kHz.
Accuracy	Reference accuracy one digit.
Distortion	
Range	.01% to 100% THD or 0 to 80 dB SINAD.
Accuracy	10% of reading or 1 dB SINAD.
Frequency Range	30 Hz to 10 kHz. Automatic operation when modulation frequency is within this range.
Residual Noise and Distortion	Less than .1% (60 dB SINAD)
AUDIO FILTERS	
Low-pass	220 kHz, seven pole Butterworth response.
Low-pass	50 kHz, seven pole Butterworth response.
Low-pass	20 kHz, three pole Bessel response.
Low-pass	3 and 15 kHz three, pole Butterworth response.
High-pass	<10 Hz, gaussian response.
High-pass	30, 300, and 3000 Hz, three pole Butterworth.
De-emphasis	25, 50, 75, and 750 s.
Filter Response	3 dB corner and time constant accuracy, 4%.
AUDIO OUTPUT	Uncalibrated, approximately 1 V rms into 600 ohms at 5000 counts on display.

TABLE 1-1 SPECIFICATIONS (CONT)

PARAMETER	SPECIFICATION
REAR PANEL CONNECTORS	
IF Output	
Frequency	1.21 MHz nominal for carriers from 10 MHz to 2 GHz, 346 kHz for carriers from 100 kHz to 2 MHz.
Level	Approximately 0 dBm into 50 Ohm load.
AM Output	DC coupled output of the AM detector. 0.01 V per 1% AM depth. Source impedance 600 ohms nominal.
FM Output	DC coupled output of the FM detector. 1 V per 100 kHz deviation. Source impedance 600 ohms nominal.
DISTORTION OUTPUT	Uncalibrated, approximately 1 V rms into 600 ohms at 5000 counts on Audio display. Recovered modulation signal with the fundamental frequency removed.
REF INPUT	TTL compatible input for external 10 MHz counter reference. Automatic switching to external signal when present.
IEEE-488 bus	Complies with IEEE-488-1978. Implements AH1, SH1, T6, TE0, L4, LE0, SR1, RL1, PP0, DC1, DT1, C0 and E1.
ANNUNCIATORS	LED indication on filter and mode switches. Digital display indicates level high, level low and unlock conditions.
POWER REQUIREMENTS	100, 120, 220, or 240 volts AC, 50 to 60 Hz, 100 VA.
OPERATING TEMPERATURE	0 To 55 degrees centigrade.
DIMENSIONS	17.75 inches (45.1 cm) wide, 5.85 inches (14.9 cm) high, 18 inches (45.8 cm) deep
WEIGHT	21 lbs. (12.7 kg)

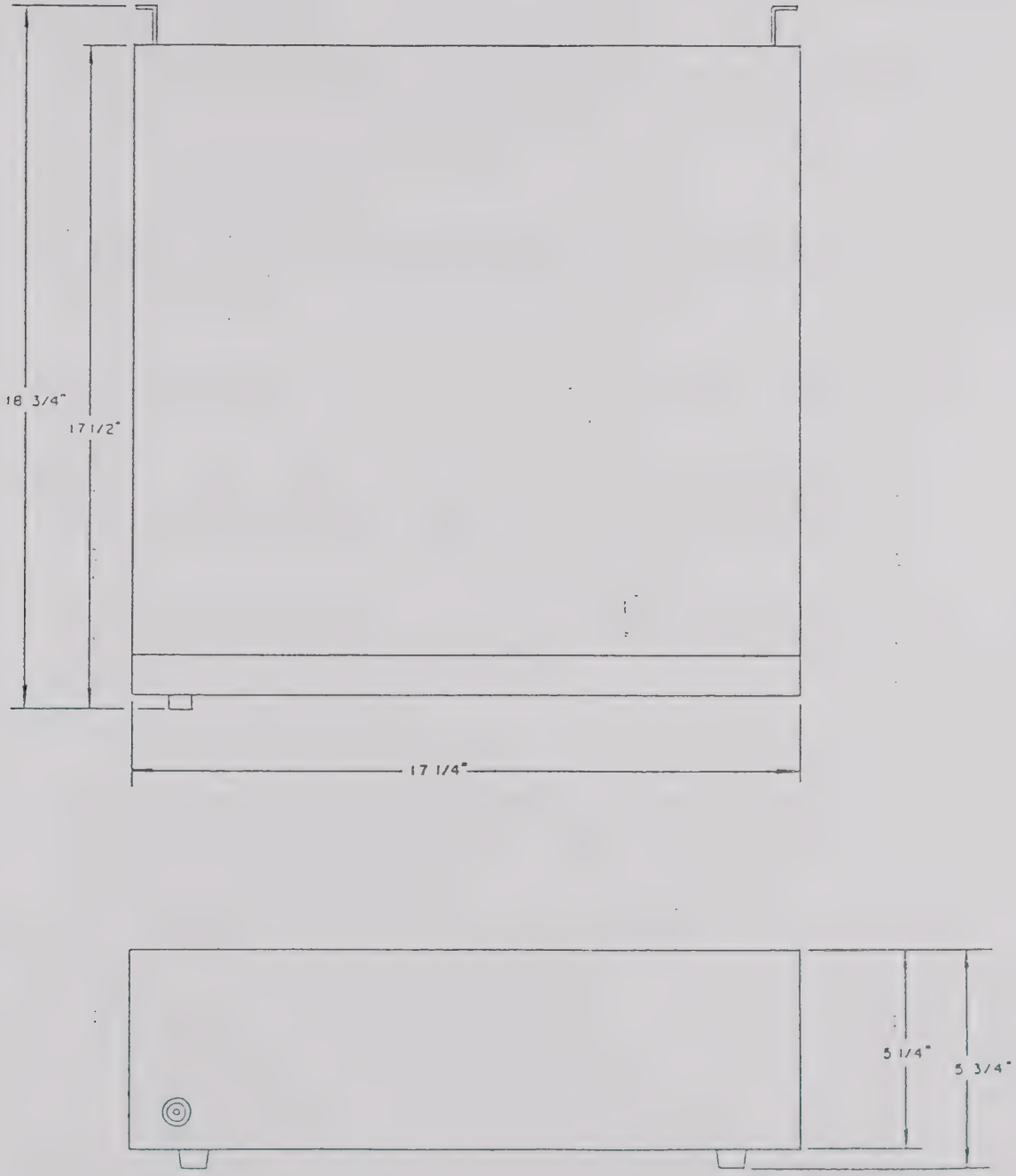

Figure 1-2. Outline Dimensions.

SECTION II
INSTALLATION

2-1. Introduction.

2-2. This section contains the installation instructions for the Model 8200 Modulation Analyzer and includes the unpacking, mounting, power requirements, cable connections, and preliminary checkout procedure.

2-3. Installation.

2-4. Unpacking. The modulation analyzer is shipped complete and is ready for use upon receipt. Unpack the instrument from its shipping container and inspect it for damage that may have occurred during shipment.

NOTE

Save the packing material and container for possible use for reshipment of the instrument.

2-5. Mounting. For bench mounting, choose a clean, sturdy, uncluttered mounting surface. For rack mounting, an accessory kit is supplied with the instrument that provides conventional rack mounting ears and rear supports. All rack mounting kits contain required hardware and installation Instructions.

2-6. Power Requirements. The instrument has a tapped power transformer and two line voltage selector switches which permit operation from 100, 120, 220, and 240 volt ±10%, 50 to 60 Hz, single phase AC power sources. Power consumption is approximately 100 VA.

CAUTION

The line voltage selector switch must be set to the correct position most nearly corresponding to the voltage of the available AC power source, and a fuse of correct rating must be installed in the fuse holder before connecting the instrument to any AC power source.

2-7. Set the line voltage selector switch, located on the rear panel to the appropriate positions as indicated on the LINE VOLTAGE SELECT chart. Check that the line fuse, F1 is correct for the selected power source.

Nominal Line Voltage	F1
100/120 V	3/4 A MDL(SB)
220/240 V	3/8 A MDL(SB)

2-8. Power Fail Protection. If the line voltage drops more than 10% below nominal, the power fail protection circuit automatically isolates the RAM and provides battery power from an internal lithium cell, rated at 3.0 V and 160 mAh, with a life expectancy of more than five years. Simultaneously the display is blanked and all internal processes stop. Normal operation resumes when nominal line voltage is restored. All conditions that existed before the loss of AC power, except remote mode, will be re-established. If another power failure occurs during the restart process, the instrument will discard the previous data and perform an initialization restart.

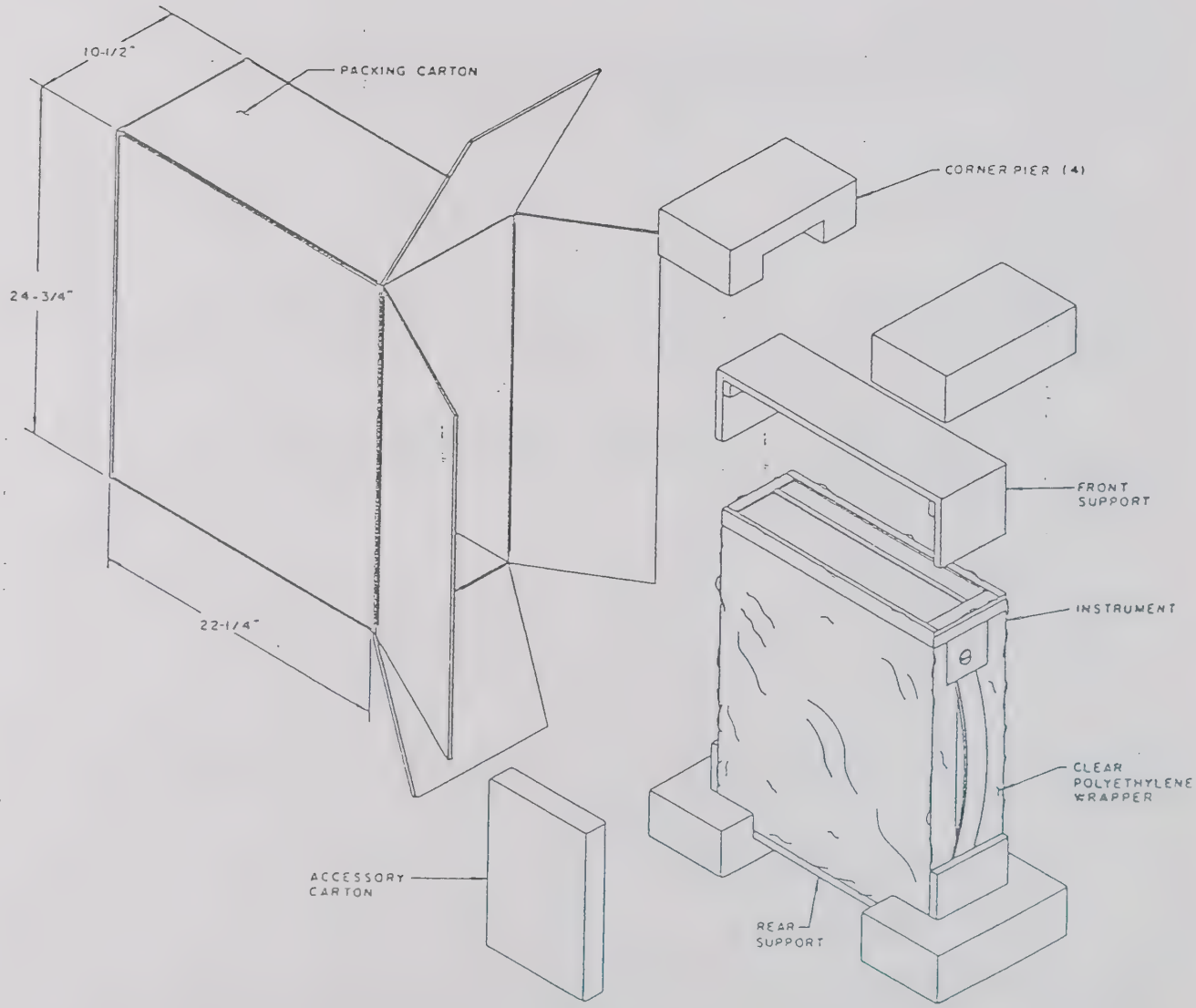

Figure 2-1. Packing and Unpacking Diagram

2-9. Cable Connections. Cable connections required depend on the use of the instrument. Connecting cables are not supplied. Cable connections that may be required are as follows:

a. RF IN. RF input, 50 ohms nominal input impedance. Type N connector.

b. AF OUT. Audio output, 600 ohms source impedance, 1 volt rms level at 5000 counts on the digital panel meter display. Type BNC connector.

c. IF OUT. IF output, 50 ohms nominal source impedance, 0 dBm level. Type BNC connector.

d. AM OUT. AM output, 600 ohms source impedance. Approximately 0.01 V per 1% AM output. Type BNC connector.

e. FM OUT. FM output, 600 ohms source impedance. Approximately 1 V per 100 kHz deviation. Type BNC connector.

f. DIST OUT. Distortion output, 600 ohms source impedance. Approximately 1 V rms at 5000 counts on the digital panel meter display. Type BNC connector.

g. EXT REF. External 10 MHz counter reference, impedance and level requirements are TTL compatible, switching is automatic. Type BNC connector.

2-10. Preliminary Check.

2-11. The preliminary check verifies that the instrument is operational and should be performed before the instrument is placed into use. Perform the preliminary check as follows:

a. Connect the power cord to the instrument and the desired power source. Refer to paragraph 2-6 for proper power application.

b. Set the POWER ON/OFF switch to ON. The carrier display should contain the instrument firmware number and the other displays all dashes for a period of about three seconds followed by a normal data display corresponding to the settings of the instrument when it was last switched to OFF.

NOTE

The INIT function sets the instrument to a predetermined initialized state, as shown on Table 2-1.

c. Depress the INIT key. This will cause the POWER ON display to reappear for about three seconds followed by this display:

	CARRIER	AUDIO	MODULATION	BUS/PRGM
Flashes:	200.00000	0.0	0.000	99
And finally:	unloc	[==]	[==]	99

d. The instrument can display four sets of numerical data at a time. To determine if RF level is active, depress the FREQ key and enter .2 GHz using the numeric key pad. Depress the LEVEL key. The CARRIER display should

2-11. (Cont.)

indicate approximately -70.0 dBm.

e. Depress each of the illuminated key switches and verify that the associated annunciators operate properly.

TABLE 2-1. INITIALIZED STATE

Frequency	Auto
RF Level	Auto
SINAD	Off
Audio Frequency	Active
Distortion	Off
AM	Off
FM	Active
PM	Off
PGM	99
High-pass	30
Low-pass	15
De-emphasis	Off
Detector	±
All Other Functions	Off

SECTION III
OPERATION

3-1. Introduction.

3-2. Section III contains the operating controls, indicators, and connectors description and functions, initial conditions, and operating instructions for the Model 8200.

3-3. Operating controls, Indicators, and Connectors.

3-4. The controls, indicators, and connectors used during operation of the instrument are listed in Table 3-1 and shown in Figures 3-1 and 3-2.

3-5. Operating Instructions.

3-6. The operating instructions for the Model 8200 are presented as follows:

a. Initial conditions.

b. Local operation.

c. IEEE-488 bus operation.

3-7. Initial Conditions.

3-8. Initialize the Model 8200 as follows:

a. Connect the power cord to the instrument and the desired power source. Refer to paragraph 2-6 for proper power application.

b. Set the POWER ON/OFF switch to ON. The carrier display should contain the instrument firmware number and the other displays all dashes for a period of about three seconds followed by a normal data display corresponding to the settings of the instrument when it was last switched to OFF.

NOTE

The INIT function sets the instrument to a predetermined initialized state, as shown on Table 2-1.

c. Depress the INIT key. This will cause the POWER ON display to reappear for about three seconds followed by this display:

	CARRIER	AUDIO	MODULATION	BUS/PRGM
Flashes:	200.00000	0.0	0.000	99
And finally:	unloc	[==]	[==]	99

d. The instrument can display four sets of numerical data at a time. To determine if RF level is active, depress the FREQ key and enter .2 GHz using the numeric key pad. Depress the LEVEL key. The CARRIER display should indicate approximately -70.0 dBm.

e. Depress each of the illuminated key switches and verify that the associated annunciators operate properly.

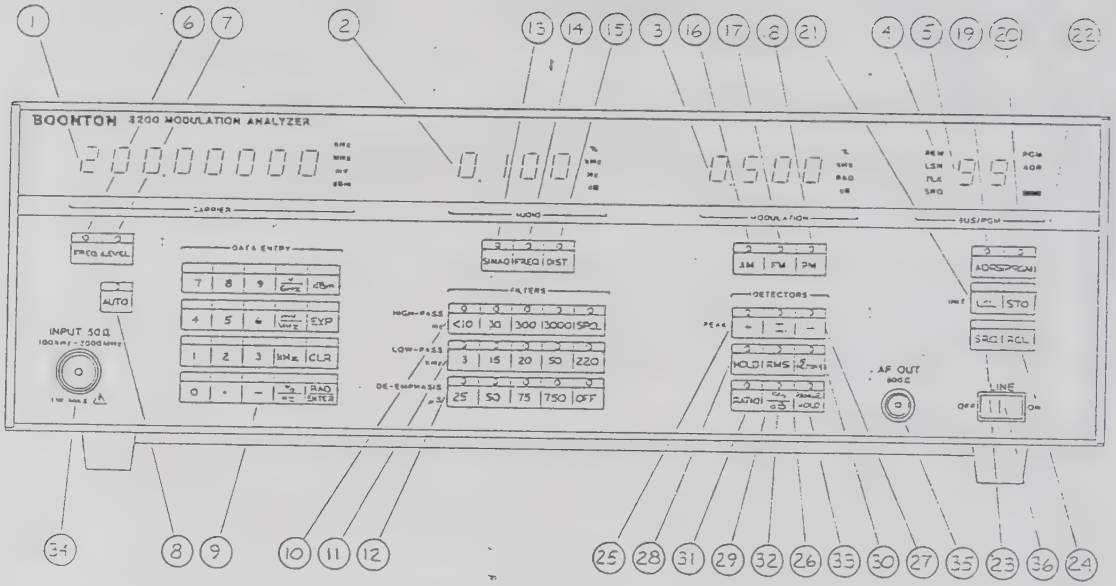

Figure 3-1

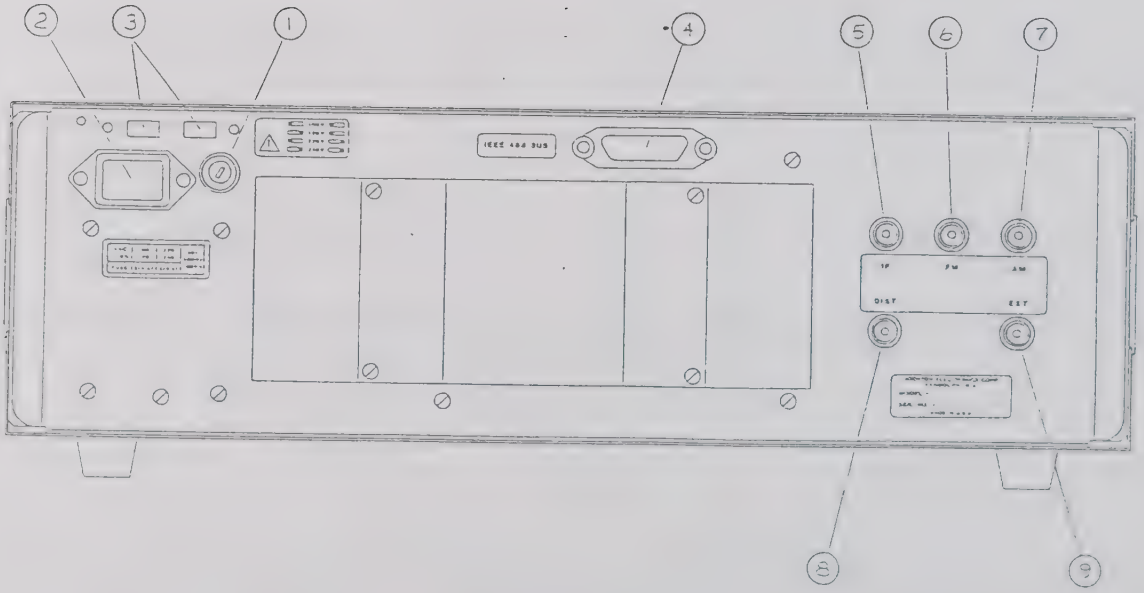

Figure 3-2

3-9. Local Operation.

3-10. Carrier Frequency Selection and Display. Carrier frequency selection and display can be performed manually or automatically.

3-11. Manual Selection and Display. To manually select and display the carrier frequency proceed as follows:

a. Apply a carrier frequency signal to the RF IN connector.

b. Depress the FREQ key. The LED will light to indicate that the carrier frequency function is active. Only one primary function can be active at any time and that function will remain active until a different primary function is selected.

c. Utilize the keypad and enter the known carrier frequency.

1. Any frequency within the range of the instrument may be entered from the keypad using any consistent combination of numbers and units.

2. It is not necessary to enter any trailing zeros, nor is it necessary to depress the ENTER key if a units key is used.

3. If at any time prior to entry the wrong digit is entered, depress the CLR key to clear the input and restore the previous frequency display.

4. Subsequent new frequencies may be entered without depressing the FREQ key each time. The function keys are used only to change the primary active function.

d. After entering the carrier frequency, depress the kHz, MHz, GHz or Hz key. The display will indicate the carrier frequency.

For example: To enter 82.15000 MHz, depress the (8) key. The CARRIER key display will show ('8). The tick mark (') always indicates that the number displayed has not yet been entered. As successive digits are entered, each digit will appear in the right-most position with the previous digits left-shifted. After entering 82.15 the display will contain ('82.15). Depress the MHz key to complete and enter the number. The display will now show 82.15000 MHz.

e. Depress the kHz key, The display program will rescale the number to the requested units if possible: otherwise the request is ignored. The GHz key may be used for convenience when entering frequency; however, the display will only indicate in MHz or kHz as in our example 82150.00 kHz.

3-12. Automatic Selection and Display. To automatically select and display the carrier frequency proceed as follows:

a. Apply a carrier frequency signal to the RF IN connector.

b. Depress the FREQ key. The LED will light to indicate that the carrier frequency function is active.

c. Depress the AUTO key. The LED will light to indicate that the

3-12. (Cont.)

automatic frequency setting is now active. If a carrier is present, the instrument will acquire, measure and display the carrier frequency. If no carrier is present the CARRIER display will indicate 'UNLOC'.

3-13. Carrier Level Selection and Display. Carrier level selection and display can be performed manually or automatically.

3-14. Manual Selection and Display. To manually select and display the carrier level proceed as follows:

a. Apply a carrier frequency signal at a known carrier level and set carrier frequency as described in paragraph 3-11 and 3-12.

b. Depress the LEVEL key. The LED will light to indicate that the carrier level function is active.

c. Utilize the keypad and enter the known carrier level in units of power ratio (dBm) or voltage (mV or V).

For example: To enter -16.5 dBm, depress the (-), (1), (6), (.), and (5) keys. The CARRIER display will show -16.5. Depress the dBm key to complete the entry. The display will now show -16.5 dBm. The instrument is now set to accept a carrier level of -16.5 dBm.

1. Any level within the range of the instrument may be entered from the keypad using any consistent combination of numbers and units.

2. It is not necessary to enter any trailing zeros, nor is it necessary to depress the ENTER key if a units key is used.

3. If at any time prior to entry the wrong digit is entered, depress the CLR key to clear the input and restore the previous level display.

4. Subsequent new levels may be entered without depressing the LEVEL key each time. The function keys are used only to change the primary active function.

5. After entering the carrier level, depress the dBm, V, or mV key. The display will indicate the carrier level. The display program will rescale the number to the requested units if possible; otherwise the request is ignored.

6. To convert the input level in dBm to an equivalent voltage, across the 50 ohm input impedance of the instrument, depress the mV or V key. The CARRIER display will indicate in mV or V. For example, a -16.5 dBm level will be converted to 33.45 mV. Depress the dBm key to restore the -16.5 dBm indication.

3-15. Automatic Selection and Display. To automatically select and display the carrier level proceed as follows:

a. Apply a carrier frequency signal to the RF IN connector and set carrier frequency as described in paragraph 3-11 and 3-12.

3-15. (Cont.)

b. Depress the Level key. The LED will light to indicate that the carrier level function is active.

c. Depress the AUTO key. The LED will light to indicate that the automatic level setting is now active. If a carrier is present, the instrument will acquire, measure and display the carrier level. If no carrier is present the CARRIER display will indicate 'UNLOC'.

3-16. Modulation-Mode Selection. The Model 8200 can measure amplitude, frequency, or phase modulation using peak or RMS detectors. Additionally, modulation results may be displayed as absolute or ratio in % or dB.

NOTE

The '[==]' display indicates that automatic ranging is in progress or that the display is overranged.

3-17. AM Mode Selection. To select and measure AM proceed as follows:

a. Apply a carrier with AM to the RF IN connector.

b. Perform the carrier frequency and level mode selections.

c. Depress the AM key. The LED will light to indicate that the AM function is active.

d. Depress the AUTO key. The MODULATION display will indicate the AM modulation %. Modulation range selection is automatic.

3-18. FM Mode Selection. To select and measure FM proceed as follows:

a. Apply a carrier with FM to the RF IN connector.

b. Perform the carrier frequency and level mode selections.

c. Depress the FM key. The LED will light to indicate that the FM function is active.

d. Depress the AUTO key. The MODULATION display will indicate the FM modulation in kHz. Modulation range selection is automatic.

3-19. PM Mode Selection. To select and measure PM proceed as follows:

a. Apply a carrier with PM to the RF IN connector.

b. Perform the carrier frequency and level mode selections.

c. Depress the PM key. The LED will light to indicate that the PM function is active.

d. Depress the AUTO key. The MODULATION display will indicate the PM modulation in RAD. Modulation range selection is automatic.

3-20. Ratio Measurement. The following ratio measurement instructions can be

3-20. (Cont.)

used with all three modulation modes to perform ratio measurements.

a. Select the appropriate modulation mode.

b. Depress the RATIO key.

c. Depress the %/dB key to display ratio in dB. The MODULATION display will indicate approximately 0 dB.

d. Change the modulation. The display will now display the new modulation as a ratio in dB with respect to the previous modulation value.

e. Depress the %/dB key. The display will now indicate the ratio in %.

f. Depress the RATIO key to cancel this mode.

3-21. Range Hold. The RANGE HOLD key is used to eliminate modulation display autoranging. It may be used for any of the above measurements. Operate the RANGE HOLD function as follows:

a. Select the appropriate modulation mode.

b. Select the desired detector and ratio, if desired.

c. Depress the RANGE HOLD key to prevent autoranging.

d. Depress the RANGE HOLD key again to resume autoranging.

3-22. Modulation range can be set as follows:

a. Select the appropriate modulation mode.

b. Depress the RANGE HOLD key to eliminate autoranging. (LED illuminated.)

c. Enter the nominal modulation into the modulation display using the numeric key pad.

d. Complete the data entry with the appropriate units key.

e. Depress the AUTO key to resume measurement on the selected range.

3-23. Ratio Measurement, Set Reference. Perform the set reference measurement as follows:

a. Select the appropriate modulation mode.

b. Use the keypad and enter the desired reference modulation. (Deviation % AM or RAD)

c. Depress the Ratio key to display the modulation value as a ratio using the entered value as a reference.

d. Select dB or % as desired.

3-23. (Cont.)

e. Depress the RATIO key again, the display will indicate the reference modulation.

f. Depress the AUTO key to resume modulation measurements.

3-24. Audio Detector Selection and Measurements. The instrument is capable of measuring modulation using peak or rms detectors.

3-25. Peak Detectors measurement. Perform the measurement as follows:

a. Select the appropriate modulation mode.

b. Select the (+), (-), or (±) key as desired. The MODULATION display will indicate the modulation waveform peak value as selected. The (±) key selects the arithmetic average of the (+) and (-) peaks.

c. Depress the detector HOLD key to hold a measurement peak.

d. Depress the detector HOLD key again to release the hold measurement peak.

3-26. RMS Detectors measurement. Perform the measurement as follows:

a. Select the appropriate modulation mode.

b. Select the RMS or $\sqrt{2}$ RMS key as desired. The MODULATION display will indicate the rms value of the modulating waveform or rms value calibrated in peak for sinewaves.

c. Depress the detector HOLD key to hold a measurement peak.

d. Depress the detector HOLD key again to release the hold measurement peak.

3-27. Audio Filter Selection and Measurements. The instrument is equipped with high-pass, low-pass, and de-emphasis filters. The filter selection is determined by what type measurement is to be made; however, the minimum bandwidth consistent with the measurement parameters should be used to minimize noise errors. For example, when measuring a carrier with modulation at a 1 kHz rate, the 3 kHz low-pass filter is recommended. High-pass filter selection is not as critical, but proper filter selection can minimize errors.

NOTE

The filter selection keys are mutually exclusive; therefore, depressing one of the keys will cancel the others.

3-28. High-pass filter selection and measurement. The following four high-pass filters are available: <10, 30, 300, and 3000 Hz. Select the high-pass filter as follows:

a. Select the appropriate modulation mode.

3-28. (Cont.)

b. Select the desired ratio measurement.

c. Select one of the four high-pass filters and depress the key.

d. Observe the modulation display. This display is the modulation reading measured utilizing the high-pass filter selected.

3-29. Low-pass filter selection and measurement. The following five low-pass filters are available: 3, 15, 20, 50, and 220 kHz. Select the low-pass filter as follows:

a. Select the appropriate modulation mode.

b. Select the desired ratio measurement.

c. Select one of the five low-pass filters and depress the key.

d. Observe the modulation display. This display is the modulation reading measured utilizing the low-pass filter selected.

NOTE

(1) The operating program controls the highest low-pass filter permitted based on the carrier frequency and will ignore any other filter selections. Below 10 MHz, the maximum low-pass bandwidth is 50 kHz and below 500 kHz, the maximum low-pass bandwidth is 15 kHz.
(2) The low-pass 20 kHz filter is a Bessel type filter provided for non-sinusoidal modulation measurements.

3-30. De-emphasis filter selection and measurement. The following four de-emphasis filters are available: 25, 50, 75, and 750 µs. Select the de-emphasis filter as follows:

NOTE

The de-emphasis filters can only be used for the FM modulation measurement mode and are automatically shut off by the operating program for the AM and PM modulation measurement modes. Additionally the de-emphasis filters may be placed before or after the modulation display by setting A9S1-4.

a. Select the FM modulation measurement.

b. Select the desired ratio measurement.

c. Select one of the four de-emphasis filters and depress the key.

d. Observe the modulation display or AF output. This response is the modulation measured utilizing the de-emphasis filter selected

TABLE 3-1. OPERATING CONTROLS, INDICATORS, AND CONNECTORS

Control, Indicator, or Connector	Figure and Index No.	Function
Carrier display	3-1, 1	Displays carrier frequency in kHz or MHz, and RF level in mV or dBm. Alternately displays error codes and messages.
Audio display	3-1, 2	Displays modulation frequency in Hz or kHz, and distortion in % or dBm.
Modulation display	3-1, 3	Displays modulation in; % AM, kHz FM deviation, Rad PM deviation. Also displays modulation ratio in % or dB.
Bus Status	3-1, 4	Displays current IEEE-488 bus status; REM (remote enabled), LSN (listener addressed), TLK (talker addressed),and SRQ (service request active).
Bus/PGM display	3-1, 5	Displays current program number or IEEE-488 bus address.
FREQ key	3-1, 6	Selects carrier frequency as the active function. Use before setting carrier frequency or to activate carrier frequency display.
LEVEL Key	3-1, 7	Selects carrier level as the active function. Use before setting carrier level or to activate level display.
AUTO Key	3-1, 8	Used with carrier frequency, level, or modulation function keys to enable automatic measurement operations.
DATA entry keypad	3-1, 9	Used with function keys to enter data for the following keys: carrier frequency, level, modulation reference for ratio measurements, bus address, or program number.
0 through 9 keys	3-1, 9	Numerical keys, used to select numerical quantities

TABLE 3-1. OPERATING CONTROLS, INDICATORS, AND CONNECTORS (CONT)

Control, Indicator, or Connector	Figure and Index No.	Function
. key	3-1, 9	Selects decimal point.
- key	3-1, 9	Selects a negative number.
V / GHz key	3-1, 9	Selects volts or gigahertz.
mV / MHz key	3-1, 9	Selects millivolts or megahertz.
kHz key	3-1, 9	Selects kilohertz.
% / Hz key	3-1, 9	Selects percent or hertz.
dBm key	3-1, 9	Selects decibels above 1 milliwatt.
EXP key	3-1, 9	Selects an exponential quantity.
CLR key	3-1, 9	Clears the operation.
RAD / ENTER key	3-1, 9	Selects radian or unitless quantity.

TABLE 3-1. OPERATING CONTROLS, INDICATORS, AND CONNECTORS (CONT)

Control, Indicator, or Connector	Figure and Index No.	Function
High-pass filters Hz	3-1, 10	
<10 key	3-1, 10	Selects <10 Hz filter
30 key	3-1, 10	Selects 30 Hz filter
300 key	3-1, 10	Selects 300 Hz filter
3000 key	3-1, 10	Selects 3000 Hz filter
SPCL key	3-1, 10	Toggles Special Mode
Low-pass filters kHz	3-1, 11	
3 key	3-1, 11	Selects 3 kHz filter
15 key	3-1, 11	Selects 15 kHz filter
20 key	3-1, 11	Selects 20 kHz filter
50 key	3-1, 11	Selects 50 kHz filter
220 key	3-1, 11	Selects 220 kHz filter
De-emphasis Filters µs	3-1, 12	
25 key	3-1, 12	Selects 25 µs filter
50 key	3-1, 12	Selects 50 µs filter
75 key	3-1, 12	Selects 75 µs filter
750 key	3-1, 12	Selects 750 µs filter
OFF key	3-1, 12	Turns OFF the de-emphasis filters
SINAD key	3-1, 13	Selects SINAD audio distortion measurement.
FREQ key (audio)	3-1, 14	Selects audio frequency measurement.
DIST key	3-1, 15	Selects audio distortion measurement.

TABLE 3-1. OPERATING CONTROLS, INDICATORS, AND CONNECTORS (CONT)

Control, Indicator, or Connector	Figure and Index No.	Function
AM key	3-1, 16	Selects AM modulation as the active function. Use before setting AM reference for ratio measurement or to activate AM modulation measurement.
FM key	3-1, 17	Selects FM modulation as the active function. Use before setting FM reference for ratio measurement or to activate FM modulation measurement.
PM key	3-1, 18	Selects PM modulation as the active function. Use before setting PM reference for ratio measurement or to activate PM modulation measurement.
ADRS key	3-1, 19	Selects bus address as the active function. Use before setting IEEE-488 bus address.
PRGM key	3-1, 20	Selects instrument program as the active function. Use before selecting program number for store or recall.
LCL/INIT key	3-1, 21	Causes instrument to "go-to-local" if local lockout is not active and remote is active or initialized when the instrument is in local mode.
STO key	3-1, 22	Stores instrument setup at selected program number.
SRQ key	3-1, 23	Sets IEEE-488 bus SRQ line true. Stays true until cleared by system controller or power on reset.
RCL key	3-1, 24	Recalls instrument setup from selected program number.
PEAK + key	3-1, 25	Selects + peak modulation display.

TABLE 3-1. OPERATING CONTROLS, INDICATORS, AND CONNECTORS (CONT)

Control, Indicator, or Connector	Figure and Index No.	Function
PEAK ± key	3-1, 26	Selects peak average modulation display. The display is (+ peak (+) - peak)/2.
PEAK - key	3-1, 27	Selects - peak modulation display.
HOLD key	3-1, 28	Alternate action key, used with peak or rms display, holds the maximum modulation display.
RMS key	3-1, 29	Selects a true rms modulation display.
$\sqrt{2}$ rms key	3-1, 30	Selects a true rms modulation display that is calibrated in peak for sine wave modulation.
RATIO key	3-1, 31	Alternate action key, causes the modulation to be displayed as a ratio to a previously entered modulation value.
%/dB key	3-1, 32	Alternate action key, used with the ratio key to display modulation ratio in percent or dB.
Range Hold	3-1, 33	Alternate action key used to hold the current modulation range setting.
RF IN connector	3-1, 34	RF input connector, used to apply an external RF carrier signal.
AF OUT connector	3-1, 35	AF output connector, used to connect demodulated AF signal to external test equipment.
LINE switch	3-1, 36	Switches the instrument AC power ON or OFF.

TABLE 3-1. OPERATING CONTROLS, INDICATORS, AND CONNECTORS (CONT)

Control, Indicator, or Connector	Figure and Index No.	Function
Fuseholder	3-2, 1	AC line fuseholder.
AC connector	3-2, 2	AC power connector.
Line Voltage Selector Switch	3-2, 3	Selects the desired operating voltage.
IEEE-488 Bus connector	3-2, 4	Provides a means for connecting the standard IEEE-488 bus interface cable.
IF OUT connector	3-2, 5	Provides a means for connecting the intermediate frequency signal to external test equipment.
AM OUT connector	3-2, 6	Provides a means for connecting the demodulated AM signal to external test equipment.
FM OUT connector	3-2, 7	Provides a means for connecting the demodulated FM signal to external test equipment.
DIST OUT connector	3-2, 8	Provides a means for connecting the distortion analyzer signal output to external test equipment.
EXT REF connector	3-2, 9	Provides a means for connecting an external 10.0 MHz TTL reference signal to the instruments time base circuits.

3-30. (Cont.)

e. Depress the OFF key to discontinue use of the de-emphasis filter.

3-31. Audio frequency and distortion selection and measurements.

3-32. Audio frequency measurement. Perform the audio frequency measurement as follows:

a. Select the appropriate modulation mode.

b. Depress the FREQ key located under the AUDIO display.

c. The AUDIO display will indicate the modulating frequency in Hz or kHz automatically.

3-33. Audio distortion measurement. Perform the audio distortion measurement as follows:

a. Apply a carrier with modulation to the RF IN connector.

b. Perform the carrier frequency, level, and modulation mode selections.

c. Depress the DIST or SINAD key.

d. The Audio display will indicate the distortion in %, or dB SINAD if the recovered modulation is:

1. Greater than 500 counts on the modulation display.

2. The rms detectors are not being used for modulation measurements.

3. The audio frequency is >20 Hz and <11 kHz.

3-34. Internal Functions

3-35. The entire status of the instrument, including all functions and entered values, can be saved in a program location of non-volatile memory for recall at a later time. Up to 99 such programs can be stored and recalled.

3-36. Store Function. To save the complete front-panel setup in the program memory, proceed as follows:

a. Set all instrument parameters to be stored.

b. Depress the PRGM key to make this function active. The BUS/PRGM display will contain the program location most recently referenced.

c. Key in the program location number desired (any location from 0 to 98), followed by ENTER.

3-36. (Cont.)

d. Depress the STO key to save the program.

e. Repeat steps a through d for each program to be stored.

NOTE

The STO key must be depressed each time a program is to be stored.

3-37. Recall Function. To recall a complete front-panel setup that has been stored in the non-volatile memory, proceed as follows:

a. Depress the PRGM key to make this function active.

b. Key in the program location number desired, followed by ENTER. Depress the RCL key to restore the complete status of the instrument.

NOTE

In normal use the internal memory is never erased. New programs or changes are simply written over the old ones. It is possible to erase the entire program memory by use of test switch, A9S1 located inside the instrument. Erased programs cannot be recalled.

c. After recalling a program, any panel setting may be changed manually.

3-38. Special Recall Functions. The two special recall functions are the internal modulation calibration procedure and the carrier level calibration procedure. The internal modulation calibration procedure automatically calibrates the internal detectors of the instrument. The carrier level calibration procedure utilizes an external reference signal to calibrate carrier level.

3-39. Internal Modulation Calibration Procedure. To perform the internal modulation calibration procedure proceed as follows:

a. Depress the PRGM key and enter program -1, utilizing the keyboard.

b. Depress the RCL key. The calibration sequence will begin and the carrier display will show ' - CAL -'.

c. Calibration will take approximately 80 seconds. Any calibration faults will be reported as errors. Refer to Table 3-8 for the applicable error codes.

NOTE

Use frequencies below 520 MHz and levels between -10 and +10 dBm to obtain the best calibration results for the carrier level calibration procedure.

3-40. Carrier Level Calibration Procedure. To perform the carrier level calibration procedure proceed as follows:

a. Apply a carrier signal of a known frequency and level to the RF IN connector.

b. Select the carrier frequency either manually or automatically.

c. Select the carrier level manually, set to the known input level.

d. Depress the PRGM key and enter program -2, utilizing the keyboard.

e. Depress the RCL key. The calibration sequence will begin and the carrier display will Flash ' - CAL - '.

f. Calibration will take approximately 5 seconds. Any calibration faults will be reported as errors. Refer to Table 3-8 for the applicable error codes. If there are no errors the display will return to an automatic carrier level display.

3-41. Bus Operation, Store and Recall Functions. Store and recall may be used to advantage with a bus controller. The instrument provides either temporary or long-term storage for control strings. This can be used to minimize bus traffic by storing several control setups at initialization and recalling them when needed with a simple string statement, such as: (H-P BASIC)

```
OUTPUT 718; "PG"; I; "RE"
```

Since few controllers have power fail protection, the data in the instrument's non-volatile memory is the more secure.

NOTE

Program location 99 is a read-only setup that is the same as the one provided by "initialize".

3-42. Remote Operation

3-43. Any front-panel operation of the instrument, with the exception of the LINE ON/OFF switch can be duplicated in remote operation under the direction of a IEEE-488 bus controller.

3-44. Setting the Bus Address. To set the IEEE-488 listen/talk address (MLTA), depress the bus ADRS key, enter the address by means of the key pad, and use the ENTER key to complete the entry. The address may be any decimal number from 0 to 30, inclusive. A secondary address is not implemented.

3-45. Entering the Remote Mode. The instrument is put in the remote mode by addressing it as a listener with remote enable (REN) "true". In the remote state the keyboard is disabled, except for the INIT/LOCAL key and the LINE ON/OFF switch, and the REM STATUS annunciator is on.

3-46. Returning to Local Mode. The instrument may be returned to the local mode as follows:

a. The INIT/LOCAL key is depressed, provided local lockout (LLO) is not active.

b. The go-to-local (GTL) bus command is sent.

c. Remote enable (REN) is set "false".

NOTE

The instrument must be placed in the remote mode for it to store and respond to data messages. It is not possible to store data in the local mode for execution in the remote mode.

3-47. Triggered Operation. In the remote mode the instrument can be operated in the "immediate" mode (mnemonic IM), or in the "wait-for-trigger" (WT) mode. The immediate mode is the default condition and results in the immediate transmission of requested data. The wait-for-trigger mode causes the transmission of data to be deferred until the receipt of a trigger. This aids in synchronizing the instrument's state changes to the measurement system. The wait-for-trigger mode is set when the WT mnemonic is encountered in the input string. From that point on measurement is delayed. No change will occur until one of the following events occurs:

a. "Group-execute trigger" (GET) is received.

b. The mnemonic TR (trigger) is interpreted.

c. Any mnemonic following IM (immediate) is interpreted.

NOTE

Event (c), above, or go-to-local, terminates the wait-for-trigger mode and restores the immediate mode. The wait-for-trigger mode is not active in local operation.

3-48. "Talk" Operations. The instrument may be addressed as a talker without regard for remote/local mode. When the talker state is set by the bus controller, the instrument sends a character string which is determined by the current talk mode. One of five different talk modes is selected by sending the appropriate mnemonic with the signal generator addressed as a listener. The selected mode will remain in effect until changed. The various talk modes are listed in Table 3-2.

TABLE 3-2. TALK MODES

Mode	Mnemonic	Description
Status	TS	If an error occurs, the error number is returned. Zero is the normal status. See paragraph 3-53.
Value	TV	The argument of the active function is returned as a string. All values are in basic units (Hz, dB, %, etc.) except RF level voltage, which is in mV and FM deviation which is in kHz.
Learn	TL	A compressed parameter string of 81 characters, the last of which is always the ASCII ($), is returned. This string can be sent back to the instrument to restore the exact state which defined it, but it must be sent as a complete line without alteration. When the ($) character is encountered in the input buffer, the learn mode is automatically activated. While this form provides a compact and fast method to save and restore settings, it bypasses much of the error control and therefore must be used with caution.
Program	TP	The program mode returns a six-digit number which uniquely identifies the firmware.
Function	TF	The function mode returns a string of four ASC11 characters in hex notation representing a 16 bit binary number which identifies the state of all functions. The bit assignments are arranged to allow for string or byte oriented decoding. The various characters are listed in Table 3-3.

TABLE 3-3. TF MODE

Function/Status	Binary Word	ASC11 String Ø C A 4
Manual Tuning	Ø	
Manual Level	Ø	
Manual Modulation Range	Ø	
Special Function	Ø	
Unlocked	1	
Unleveled	1	
Ext Reference	Ø	
Audio Display overranged	Ø	
Distortion Display	1	
Sinad Display	Ø	
Carrier Level Display	1	
Carrier Frequency Display	Ø	
PM Display	Ø	
FM Display	1	
AM Display	Ø	
Audio Frequency Display	Ø	

3-49. End-of-String (EOS) Control. The instrument provide several end-of-string options to accommodate a wide variety of controllers. The instrument always terminates on EOI (end or identify line of the IEEE-488) true and always sends EOI true with the last character of every string. In addition, CR, LF, or CRLF may be used. The use of CR and LF is selected by switch positions 6 and 7 of the OPTION/TEST switch A9S1. Refer to Figure and paragraph for the location and operation of the OPTION/TEST switch A9S1. The EOI is not affected by A9S1 switch settings.

TABLE 3-4. EOS SELECTED

Switch A9S1-6	Switch A9S1-7	Terminates as Listener	Sends as Talker
Open	Open	LF or CRLF	CRLF
Open	Closed	CR	CRLF
Closed	Open	CR	CR
Closed	Closed	LF	LF

0 = Open 1 = Closed

3-50. Using "Service Request" (SRQ). The instrument may be configured to set SRQ true when it is in the remote mode and an error occurs. This is enabled at by setting the OPTION/TEST switch A9S1-5 to ON. The bus controller must be programmed to respond to SRQ true. In the usual case, the controller then executes a serial poll to determine which device caused SRQ to be true. If the instrument is the requesting device, it will respond to the serial poll with a single byte which expresses the error code number (see paragraph 3-53) in excess 64. The serial poll will clear the SRQ line automatically. The various serial poll status bytes are listed in Table 3-5.

TABLE 3-5. SERIAL POLL STATUS BYTES

Serial Poll Status Byte		Interpretation
Decimal	Hexadecimal	
0	0	Instrument is not requesting service
64	40	Panel SRQ key request
65	41	Error 1
66	42	Error 2
--	--	----------
89	59	Error 23
--	--	----------
94	5E	Error 30
--	--	----------
100	64	Error 36

NOTES: (1) The action to be taken by the controller to correct the problem is completely application-dependent. "Soft" errors generally result from errors in the controller program or from sequence errors caused by interrupting and re-starting the test sequence. The error-trapping capability in the instrument will prevent the program from continuing to run when results would be unpredictable. (2) A serial poll is not the only method that can be used to respond to SRQ. In small systems only the instrument may be capable of using SRQ. In this situation there is no need to execute a serial poll since the identity of the requesting device is known. The error code may be obtained directly from the status (TS) talk mode (see paragraph 3-46). The SRQ line must then be cleared by sending a clear errors command (CL).

TABLE 3-6. BUS COMMAND RESPONSES

Commands	Instrument Response
UNIVERSAL COMMAND GROUP	
Device Clear (DCL)	Clear errors.
Local Lockout (LLO)	Disables LOCAL key.
Serial Poll Enable (SPE)	Sets talk mode for poll response.
Serial Poll Disable (SPD)	Restores talk mode before poll.
ADDRESSED COMMAND GROUP	Response if MLA true; otherwise ignored.
Selective Device Clear (SDC)	Same as device clear (DCL).
Go to Local (GTL)	Sets LOCAL mode.
Group-Execute Trigger (GET)	Triggers a measurement.
ALL OTHERS	Ignored.

3-51. Bus-Command Responses. IEEE-488 bus commands are sent by the controller to all devices on the bus (Universal Command Group) or to addressed devices only (Addressed Command Group). The response of the instrument is listed in Table 3-6.

3-52. Program-Function Mnemonics. Each front-panel key is assigned a program mnemonic. Programming the mnemonic, followed by unit values, if appropriate, is analogous to manual front-panel entry. In addition, other program mnemonics are used for functions that are applicable only in remote operation. Table 3-7 lists all program function mnemonics.

3-53. Number Formatting. Number-formatting rules are as follows:

a. Fixed or floating formats are accepted.

b. The optional + or - sign may precede the mantissa and/or the exponent.

c. The optional decimal point may appear at any position within the mantissa. A decimal point in the exponent is ignored.

d. The optional "E" for exponent may be upper or lower case.

e. ASCII characters having hexadecimal values of 0 to 23 and 25 to 2C are ignored.

TABLE 3-7. PROGRAM FUNCTION MNEMONICS

Functions: Functions which take numerical arguments. Only one primary function may be active at a time.

Mnemonic	Function	Argument Range
FR	RF carrier Frequency	100 kHz to 2000 MHz
RL	RF carrier Level	1 mV to 2 V (-47 dBm to 19 dBm)
FM	FM deviation	0 - 500 kHz, peak
PM	PM deviation	0 - 500 radians, peak
AM	AM depth	0 - 200%
PG	Program number	0 - 99

Units. Numbers not followed by units are assigned default units. Default units are Hz, Rad, %, or dimensionless as appropriate for the active function:

Mnemonic	Function
HZ	Hz
KH	kHz
MH	MHz
GH	GHz
DB	dBm
VO	V
MV	mV
RA	rad

Audio display:

Mnemonic	Function
AF	Audio frequency display
SI	Distortion display in dB SINAD
DN	Distortion display in %

TABLE 3-7. PROGRAM FUNCTION MNEMONICS (CONT)

Measurement control:

Mnemonic	Function
AU	Activates measurement mode, automatic frequency or level acquisition depending on active function.

Filter selections:

Mnemonic	Function	Mnemonic	Function
D1	de-emphasis 25 us	H3	300 Hz high-pass
D2	de-emphasis 50 us	H4	3000 Hz high-pass
D3	de-emphasis 75 us	L1	3 kHz low-pass
D4	de-emphasis 750 us	L2	15 low-pass
D5	de-emphasis Off us	L3	20 low-pass
H1	<10 Hz high-pass	L4	50 low-pass
H2	30 Hz high-pass	L5	220 low-pass

Detectors selection:

Mnemonic	Function
P1	Peak +
P2	Peak
P3	Peak -
PH	Peak hold ON
PX	Peak hold OFF
RM	rms
PR	$\sqrt{2}$ rms
RX	Ratio OFF
RP	Ratio %
RD	Ratio dB

TABLE 3-7. PROGRAM FUNCTION MNEMONICS (CONT)

Talk Mode functions:

Mnemonic	Function
TS	Set talk mode to return error status
TL	Set talk mode to return a learn string
TV	Set talk mode to return the active argument
TP	Set talk mode to return the firmware reference number
TF	Set talk mode to return selected functions and instrument status.

Program control:

Mnemonic	Function
ST	Store
RE	Recall

Display Functions:

Mnemonic	Function
UD	Enable front panel display
BL	Disable and blank front panel display

Test function:

Mnemonic	Function
CH	Self check.

Trigger Mode Functions:

Mnemonic	Function
WT	Set the wait-for-trigger mode
IM	Set the immediate trigger mode
TR	Trigger (alternative to group execute trigger)

TABLE 3-7. PROGRAM FUNCTION MNEMONICS (CONT)

Control Functions:

Mnemonic	Function
CL	Clear errors
EI	Enable SRQ
DI	Disable SRQ
PD	Pre-display de-emphasis
AD	Post-display de-emphasis
SP	Special mode ON
SX	Special mode OFF
R1	Modulation range 1 0-5.000
R2	Modulation range 2 5-50.00
R3	Modulation range 3 50-500.0
RØ	Modulation range AUTO

3-54. Programming-Data-String Format. Programming-data-string formats are as follows:

a. The programming sequence is in natural order, that is, a function mnemonic is sent first followed by the argument, if appropriate.

b. ASCII characters having hexadecimal values of 0 to 23 and 25 to 2C are ignored. The ASCII ($), hexadecimal 24, is reserved. Lower case letters are automatically changed to upper case.

c. A primary-function mnemonic sent without a following argument will make the specified function active.

d. The programming-data string may not exceed 128 characters and may be terminated with LF, CR, and/or EOI (see paragraph 3-44).

e. Interpretation of the data string does not begin until termination occurs.

f. If units are unspecified for any argument, default units are automatically appended. The functions AM, PM, STO, and RCL always use default units.

g. If a units mnemonic is sent without a corresponding argument, the display will reflect the change provided that:

1. The units are appropriate to the active function; otherwise an error will result.

2. The display is enabled.

3. The display can accommodate the rescaled number; otherwise no change will result.

h. Errors are detected during interpretation. The occurrence of an error will display the error code if the display is enabled, and will set SRQ, if enabled by the internal option switch. The error and SRQ can be cleared by a serial poll, or a clear error instruction (CL). All errors cause previous valid parameters to be restored. No new input can be processed until an existing error is cleared.

i. Examples of Programming Strings. The following are examples of typical programming strings (all in H-P BASIC).

1. `OUTPUT 718;"FR185.6MH"`

2. `OUTPUT 718;"FR185600000"` [Hz is optional]

3. `OUTPUT 718;"FR+1.856E+08HZ"`

4. `OUTPUT 718;"FR1.85600E8"`

5. `OUTPUT 718;"FR0.1856GH"`

3-55. Error Codes. Table 3-8 lists all error codes.

TABLE 3-8. ERROR CODES

Error Code	Description
(1)	Illegal carrier frequency.
(5)	Illegal RF input level in dBm
(6)	Illegal AM input level in dBm.
(10)	Illegal program number.
(11)	Units error. Units do not match primary active function.
(12)	Illegal FM number.
(13)	Program requested is empty.
(14)	Illegal Listen/Talk address.
(15)	Display overflow. Too many characters entered.
(16)	Non-existent function mnemonic.
(17)	Illegal learn-mode string format.
(18)	I/O buffer overflow. Input string exceeds 128 characters.
(20)	Illegal RF input voltage.
(21)	Illegal PM deviation.
(22)	Program is recall only.
(30)	Oscillator setup error band 1
(31)	Oscillator setup error band 2
(32)	Oscillator setup error band 3
(33)	Oscillator setup error band 4
(34)	M/D chip error
(35)	To be assigned
(36)	To be assigned
(40)	AM Cal fault

TABLE 3-8. ERROR CODES (CONT)

Error Code	Description
(41)	RMS Cal fault
(42)	FM Cal fault
(43)	PM Cal fault
(44)	LEVEL Cal fault

NOTE

The error code as shown above will appear in the carrier display and will be returned by the talk-status function if executed. The SRQ status byte will consist of the above code expressed in excess sixty-four. The status code 64 decimal means the SRQ was activated by the front panel SRQ key rather than by an error.

WARRANTY

Boonton Electronics Corporation warrants its products to the original purchaser to be free from defects in material and workmanship and to operate within applicable specifications for a period of one year from date of shipment, provided they are used under normal operating conditions. This warranty does not apply to active devices that have given normal service, to sealed assemblies which have been opened or to any item which has been repaired or altered without our authorization.

We will repair, or at our option, replace any of our products which are found to be defective under the terms of this warranty.

There will be no charge for parts, labor, or forward and return normal ground transportation during the first three months of this warranty.*

There will be no charge for parts, labor, or return normal ground transportation during the fourth through twelfth month of this warranty.*

Except for such repair or replacement, we will not be liable for any incidental damages or for any consequential damages, as those terms are defined in Section 2-715 of the Uniform Commercial Code, in connection with products covered by this warranty.

*For *overseas shipments*, there will be no charge for Air Freight during these specified time periods.

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